TRIUMF Summer Institute 2009

Analysis Methods at Hadron Colliders, Problem set #2

1. **Significance of Observation**
   Consider two analyses searching for Supersymmetry

   - analysis A uses a very loose selection and expects 40 signal events on a background of 173 events in 100 pb^{-1}.
   - analysis B uses a tighter selection and expects 20 signal events on a background of 53 events in 100 pb^{-1}.

   Determine

   (a) How much luminosity does each analysis need to make a 5σ observation purely statistically?

   (b) Assume now that the background has a systematic uncertainty of 10% in both cases. How much luminosity is now needed for a 5σ observation in both analyses?

2. **Background to Jets + missing E_T analysis**
   You want to make a search for Supersymmetry selecting 3 jets with $E_T > 100$ GeV and $E_T^{miss} > 200$ GeV. One of the main backgrounds is the production of a Z boson in association with jets where the Z boson decays to neutrinos.

   You find in 100 pb^{-1} that there are 63 events with a $Z \to ee$ and 48 with a $Z \to \mu\mu$ candidate with $p_T(Z) > 200$ GeV and three jets with $E_T > 100$ GeV.

   (a) How many background events from $Z(\to \nu\bar{\nu}) + 3$ jets do you predict using the electron channel? And, how many for the muon channel?

   (b) What is the statistical uncertainty on these estimates? Are the electron and muon estimate statistically consistent with each other?

   (c) Now combine the electron and muon estimate and calculate the overall prediction for the background and its uncertainty.

   Assume that the kinematic and fiducial correction factors are 1.3 for both the electron and muon channel and the fiducial correction factor is 1.2 for the electron and 1.4 for the muon case, respectively.